

Application Note

New Features for the TUSB1044A for USB3.2 Gen 2x2



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ABSTRACT

USB 3.2 Gen 2x2 is an advanced USB technology standard, representing further development of USB connection technology. This standard is defined by the USB Implementers Forum (USB-IF) and aims to provide higher data transfer speeds and a better user experience. This application note aims to comprehensively introduce USB 3.2 Gen 2x2 and how to achieve 20Gbps transfer rate by a TI TUSB1044A device.

Table of Contents

1 Introduction.....	2
2 USB 3.2 Gen 2x2.....	2
2.1 What is USB 3.2 Gen 2x2?.....	2
2.2 TUSB1044A Introduction.....	3
2.3 USB 3.2 Gen 2x2 Application With TUSB1044A.....	4
3 Summary.....	5
4 References.....	5

List of Figures

Figure 2-1. Typical USB 3.2 Gen2x2 Application with TUSB1044A.....	4
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List of Tables

Table 2-1. USB 3.2, USB 3.1, and USB 3.0 Versions and Speeds.....	2
Table 2-2. TUSB1044A Config Lane Selection.....	3

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1 Introduction

USB 3.2 Gen 2x2 is a multilane operation for new hosts and devices, allowing for up to two lanes of 10Gbps operation to realize a theoretical 20Gbps data transfer rate.

The USB 3.2 Gen 2x2 allows the user to transfer data between devices quicker, and supports backwards compatibility, addressing any concerns related to functionality with older technology. Backwards compatibility implies that new drives support existing USB specifications.

A USB Type-C connector has four pairs of metal pins functioning as *lanes* that transfer and receive data. USB 3.2 Gen 1 (5Gbps) and USB 3.2 Gen 2 (10Gbps) use one TX lane and one RX lane, based on the positioning of the connector. USB 3.2 Gen 2x2 takes advantage of all four lanes to achieve up to the theoretical 20Gbps transfer rate.

2 USB 3.2 Gen 2x2

2.1 What is USB 3.2 Gen 2x2?

While USB 4 is the latest and fastest generation, the most common USB ports on PCs and peripherals have a three in the version number, specifically USB 3.2 or USB 3.1, or even 3.0. When looking at specification sheets, note that there are generation numbers after the USB 3.2 or 3.1. For example, USB 3.2 Gen 1, USB 3.2 Gen 2, and also USB 3.2 Gen 2x2. Some ports with different version numbers actually have the same speed. [Table 2-1](#) shows different USB 3 versions and speeds.

Table 2-1. USB 3.2, USB 3.1, and USB 3.0 Versions and Speeds

USB Version	Speed	Alternate Name	Connector Type	Identical To
USB 3.2 Gen 1	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1, USB 3.0
USB 3.2 Gen 2 / Gen 2x1	10 Gbps	SuperSpeed+10Gbps	Type-A, Type-C	USB 3.1 Gen 2
USB 3.2 Gen 2x2	20 Gbps	SuperSpeed+20Gbps	Type-C	N/A
USB 3.1 Gen 1	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1, USB 3.0
USB 3.1 Gen 2	10 Gbps	SuperSpeed+10Gbps	Type-A, Type-C	USB 3.1 Gen 2
USB 3.0	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1

The 20Gbps speed is named USB 3.2 Gen 2x2, because it uses two 10Gbps lanes to give the 20Gbps speed. There is also a lesser-used version called USB 3.2 Gen 1x2, which is 10Gbps and nearly identical to USB 3.2 Gen 2. The difference is that, while USB 3.2 Gen 2 has a single, 10Gbps data lane, USB 3.2 Gen 1x2 uses two 5Gbps lanes to get to the 10Gbps total.

Both the 5Gbps and 10Gbps speeds are available with either USB Type-A or USB Type-C connectors. USB Type-A ports have the traditional, rectangular connectors that can only be inserted one way. USB Type-C ports are smaller, oval-shaped and reversible.

However, if using USB 3.2 Gen 2x2 (20Gbps), then the USB Type-C is being used. The Type-A ports cap out at 10Gbps. Also, though rare, the USB 3.2 Gen 1x2 (also 10Gbps) can only use USB Type-C.

When using a USB 3.2 Gen 2 port, and if the user needs to take advantage of the 10Gbps speed, use a cable that supports 10Gbps and a peripheral that does the same. If 20Gbps speeds is a requirement, all three pieces: the *port*, the *peripheral* and the *cable*, must support that speed.

2.2 TUSB1044A Introduction

TI TUSB1044A is an USB Type-C® Alt Mode redriver switch that supports data rates up to 10Gbps. The device is used for configurations C, D, E, and F from the VESA® DisplayPort™ Alt Mode on USB Type-C Standard. The redriver recovers incoming data by applying equalization that compensates for channel loss, and drives out signals with a high differential voltage. Each channel has a receiver equalizer with selectable gain settings. Equalization control for upstream and downstream facing ports can be set using UEQ[1:0], and DEQ[1:0] pins respectively or through the I2C interface.

The TUSB1044A also supports USB 3.2 data rates up to 20Gbps when operating in USB 3.2 Gen 2x2 mode (USB32_BY2_EN = 1) and up to 10Gbps when operating in USB3.2 Gen 2 × 1 mode (USB32_BY2_EN = 0).

The TUSB1044A is intended to reside between a Host and a USB-C receptacle or between a USB device and a USB-C receptacle. The TUSB1044A automatically detects whether or not the interface is operating at USB 3.2 Gen 2x2 or x1. If it determines the USB interface is operating at USB 3.2 Gen 2 × 1, then it will disable the unused lane to conserve power.

TUSB1044A configured for USB 3.2 Gen 2x2 mode determines if the link is operating in USB 3.2 Gen 2x2 or in USB 3.2 Gen 2x1. If the link is USB 3.2 Gen 2x2, then TUSB1044A operates with one port operating as a USB 3.2 Gen 2x1 port and the remaining port following the lead of the other port. The port functioning as a USB 3.1 Gen 2x1 port is called the config lane. The determination of the config lane is based solely on the Type-C orientation. For normal orientation (FLIP = L), Port 1 is the config lane. For the flipped orientation (FLIP = H), Port 2 is the config lane. [Table 2-2](#) shows the selection of config lane.

Table 2-2. TUSB1044A Config Lane Selection

Flip	Configure Lane	Non-Configure Lane
L	DRX1-URX1	DRX2-URX2
	UTX1-DTX1	UTX2-DTX2
H	DRX2-URX2	DRX1-URX1
	UTX2-DTX2	UTX1-DTX1

2.3 USB 3.2 Gen 2x2 Application With TUSB1044A

A typical application of the TUSB1044A device is shown in [Figure 2-1](#). The device can be configured either through the GPIO pins or through the I2C interface.

In GPIO mode the TUSB1044A is enabled for USB3.2 Gen 2x2 mode when all the following conditions are true: DIR1 pin = H, DIR0 pin = L or H, CTL0 pin = H and CTL1 pin = H.

In I2C mode, USB3.2 Gen 2x2 mode is disabled by default. USB3.2 Gen 2x2 in I2C mode is enabled if either of the following conditions is true:

At offset 0xA, USB32_BY2_EN bit = 1'b1 and CTLSEL_1:0 bits = 2'b01.

At offset 0xA, CTLSEL_1:0 bits = 2'b11, and at offset 0xC, DIR_SEL bits = 2'b10 or 2'b11

In the following example, a Type-C PD controller or microcontroller is used to configure the device through the I2C interface. In I2C mode, the equalization settings for each receiver can be independently controlled through I2C registers.

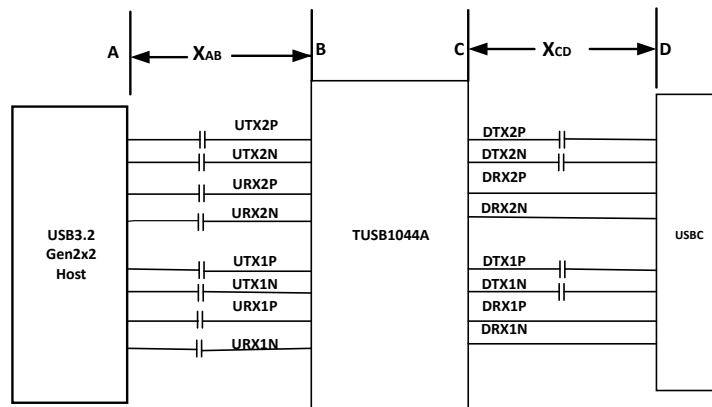


Figure 2-1. Typical USB 3.2 Gen2x2 Application with TUSB1044A

For pre-channel A to B PCB trace length X_{AB} , a good rule for FR4 trace insertion loss at 5GHz is approximately -1dB per inch. If X_{AB} is eight inches, the TUSB1044A SSEQ must be programmed to -8dB.

3 Summary

USB 3.2 Gen 2x2 takes advantage of all four lanes of type-c connector and delivers a strong performance boost for USB storage with 20Gbps data transfer rate. This application note explained the difference between different USB revisions and speed and presented a typical USB 3.2 Gen 2x2 application with TI TUSB1044A part.

4 References

- Texas Instruments, [TUSB1044A USB TYPE-C 10Gpbs Multi-Protocol Bidirectional Linear Redriver](#), data sheet.

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